Oroville Facilities Relicensing Project
Environmental Work Group

SPW5. Project Effects on Groundwater
Task 1, Phase 1. Inventory Existing Wells and Assessment of Existing Groundwater Data and Current Groundwater Monitoring Activities

May 14, 2003

Executive Summary

The Environmental Work Group developed a study plan to identify possible effects to groundwater levels and quality from project facilities and operations. Task 1 of that study plan included determining whether existing data are sufficient to evaluate potential project effects to groundwater. This report presents the results of the evaluation of existing data and need to collect additional information.

Local geology essentially eliminates potential effects to groundwater from Lake Oroville, which is underlain by relatively impermeable Mesozoic-era igneous and metamorphic bedrock. The Thermalito Forebay and Afterbay, however, are underlain by younger and more permeable volcaniclastic and consolidated alluvial sediments where groundwater recharge occurs, thus potentially affecting local groundwater.

Wells previously monitored in the vicinity of the Thermalito Forebay show that project operation raised the groundwater level about ten feet. However, no groundwater quality data are available from this area.

Numerous wells are present in the vicinity of the Thermalito Afterbay, butwith most of these arebeing private actively pumping wells and, therefore, unsuitable for measuring groundwater levels. DWR monitors several wells in the vicinity of the Afterbay, but most of these are too far from the project to be useful for determination of site specific project effects. However, groundwater levels in Butte County are monitored through an extensive groundwater level monitoring network, and there is little concern about groundwater levels (Ed Craddock, Butte County Department of Water and Resource Conservation, pers. comm.). In addition, Ssome previously monitored wells nearer the project were located and have been added to the DWR groundwater level monitoring grid., but additional wells are necessary to provide sufficient areal coverage and resolution for groundwater contours and flow gradient determinations.

Similarly, oOnly two wells near the project have been monitored for water quality, but the depth from which one well draws water is unknown and the other well is over a mile from the Afterbay. Thus, additional wells will need to be monitored to determinelittle information is available concerning groundwater quality near project facilities. Several parameters have been identified at elevated levels in project waters that could eaffects to groundwater quality. In addition, groundwater quality is a major concern for Butte County (Ed Craddock, pers. comm.) Therefore, existing wells near the Thermalito Forebay and Afterbay will be monitored to determine potential effects to groundwater quality from project features.

1.0 Introduction/Background

Relicensing participants raised a concern about the effects of project features and operations on groundwater quality downstream from project facilities. Existing and future operation of the Oroville Facilities may have

effects on the physical, chemical, and biological components of groundwater quality in the project area. Some physical, chemical, and biological data have been collected from groundwater in the project area. However, these data are not, nor were they expected to be, sufficient to determine compliance with Basin Plan criteria, goals, and objectives (CVRWQCB 1998) established for protection of groundwater beneficial uses. Additional physical, chemical, and biological data are needed to demonstrate project ~~-~~compliance with Basin Plan standards for groundwater.

Oroville Dam and Lake Oroville are underlain by relatively impermeable Mesozoic-era igneous and metamorphic bedrock, which should eliminate any groundwater effects from Lake Oroville. Downstream from the dam, the Feather River and the Thermalito Forebay and Afterbay project features are on much younger and more permeable volcaniclastic and consolidated alluvial sediments, where groundwater recharge occurs. This area is an older upland adjacent to the basin to the west. Due to the porosity of the underlying deposits, hydraulic heads of the Thermalito Forebay and Afterbay surface water features, as well as varied project-related releases to the Feather River, the Forebay and Afterbay probably contribute to locally higher groundwater levels, though the extent of this effect has not been quantified. It is possible also that groundwater quality locally reflects the characteristics of the water within these project features. To the west of the uplands are the younger alluvial deposits of the Sacramento Valley. At least two aquifer systems have been identified in the valley system. How all three systems interact is not known.

A study plan was developed and approved by the Environmental Workgroup to evaluate the effects from project facilities and operations on groundwater ~~levels and quality~~. Task 1, Phase 1 of that study plan was to determine whether existing data are sufficient to evaluate potential effects from project facilities and operations on groundwater levels and quality in the project area and develop appropriate monitoring. This report presents the results of that task.

2.0 Study Objective

The objectives of this study task are to quantify the localized effects on groundwater levels and groundwater quality from Thermalito Forebay and Afterbay operations.

3.0 Study Area

The study includes areas where groundwater is anticipated to be affected by project features as well as reference sites up gradient from potential project effects. These include areas adjacent to the west and south of the Thermalito Forebay~~, and areas adjacent to the west, south and east of the~~ and the Thermalito Afterbay.

4.0 General Approach

This study evaluates effects from project features to groundwater levels and quality in the vicinity of the Thermalito Forebay and Afterbay. This first phase was to review current groundwater monitoring data to evaluate project effects to groundwater, and, if sufficient data are not available, develop a study plan for a subsequent phase to obtain the necessary information.

An inventory of wells located in the specified field areas was made utilizing records maintained at the California Department of Water Resources (DWR). Potential impacts to groundwater from the Thermalito project features would likely occur in a shallow, unconfined setting. Therefore, wells were grouped as shallow (100 feet deep or less) or deeper. Data for well location, surface elevation, depth, design, and use were entered into a GIS database. The groundwater level and quality data from the wells was reviewed to determine localized effects on groundwater from the Thermalito Forebay and Afterbay, or whether additional data are needed.

5.0 Results and Discussion

Existing Groundwater Infrastructure – Groundwater flows in a south-southwest direction in the vicinity of the Thermalito Forebay and Afterbay. About 162 wells (Figure 1) within a two-mile radius down gradient from the Thermalito Afterbay were identified based on the Northern District DWR well log data base, which may not include all wells existing in the area. However, the available data do indicate the relative density and distribution of wells in the area. The wells were mapped with a GIS application, which places each well data point into a one mile square section location indicated on the water well driller's report. Wells were not field located for this evaluation. There are about 63 irrigation wells, 81 domestic wells, and 18 in an "other" category, which includes monitoring, municipal, and an "unknown" use designation. Wells range in depth between 15 and 745 feet with an average depth of 131 feet. Of the 162 wells, 86 are up to 100 feet in depth and 76 are greater than 100 feet in depth.

The lithology indicated on water well driller's reports was reviewed to evaluate the aquifer materials encountered in wells in the area. That review shows that there is a high degree of vertical and horizontal variability of aquifer materials. Aquifer zones are not uniform in thickness, nor is there much uniformity in the depth that different aquifer materials are encountered in area wells. Therefore, it is too simplistic to divide the total aquifer system into the initial 0 to 100 and greater than 100 foot zones called for in the study plan. Many well reports indicate that there are at least two water bodies: a confined zone and an unconfined zone. The aquifer system may also include a semi-confined character but the well log data are insufficient on which to base that determination.

The complexity of the areal and depth distribution of aquifer materials is due to the location of the environment in which the sediments forming the aquifers were deposited. The Afterbay was constructed on an older, dissected upland, consisting of coarse gravels cemented in a sandy clay matrix. The upland area is adjacent to the edge of the groundwater basin to the west where younger alluvial materials overlap the older sediments. The younger sediments consist of alluvial fan, stream, and basin deposits. At the toe of the Afterbay is an alluvial fan complex that is crisscrossed by small distributary streams. These streams trend into the basin in a south to south-southwest direction. Trending from east to west, the younger deposits transition from coarse to fine. In the subsurface, the fine clay materials of the basin deposits interfinger with the coarser sands and gravels of the alluvial fans and stream deposits. The resulting form of the local aquifer system is an irregular wedge of alluvial fan deposits juxtaposed against the older gravels to the east and the younger clays to the west.

Existing Groundwater Level Monitoring – The Northern District's current groundwater level monitoring grid in the area adjacent to the Thermalito Forebay and Afterbay was mapped to help evaluate the adequacy of data coverage. There are only thirteen monthly or semi-annual wells currently being monitored for groundwater level in the area (Figure 2). Many of the wells are too far from the project facilities to provide useful information, and large areas have little to no monitoring coverage. Monitoring that would provide information on localized effects to shallow groundwater levels from the Thermalito Afterbay is not currently being conducted.

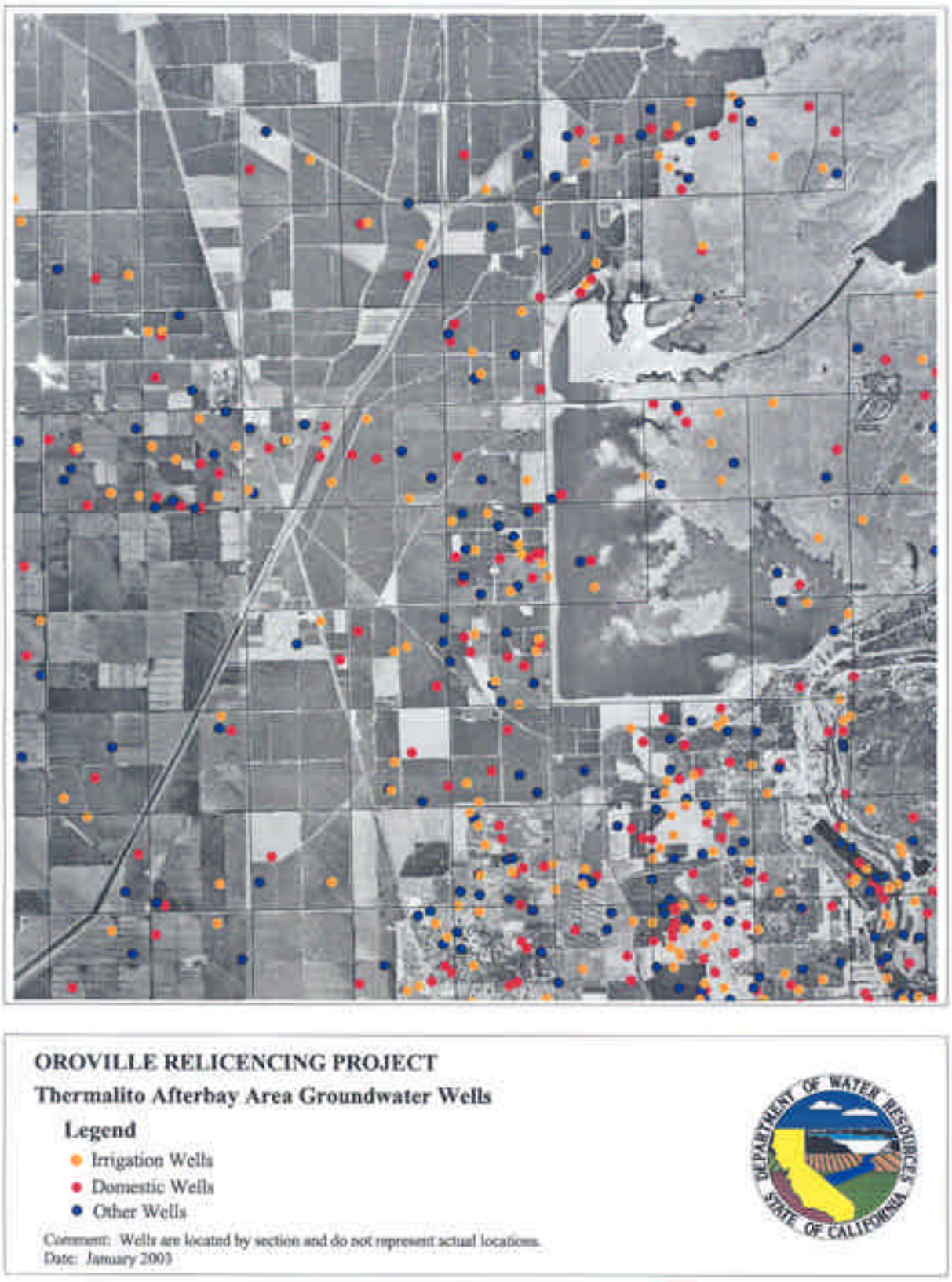

Figure 1. Wells in the vicinity of the Thermalito Forebay and Afterbay

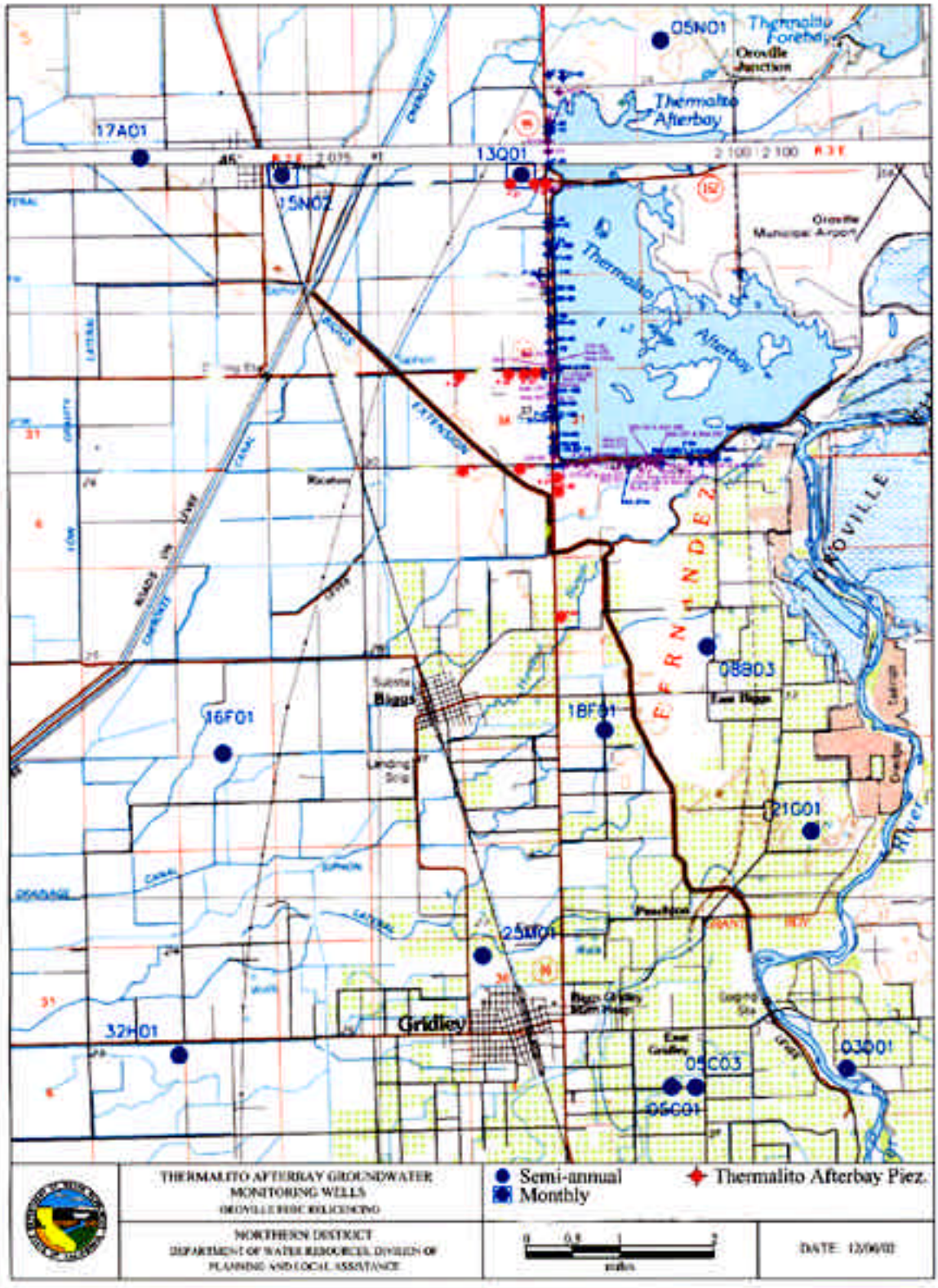

Figure 2. Current DWR groundwater level monitoring wells

Two wells potentially affected by the Thermalito Forebay had been monitored for water levels from 1959 to 1982. These wells show that groundwater elevation was increased by about 10 feet following project completion in 1969 (Figure 3).

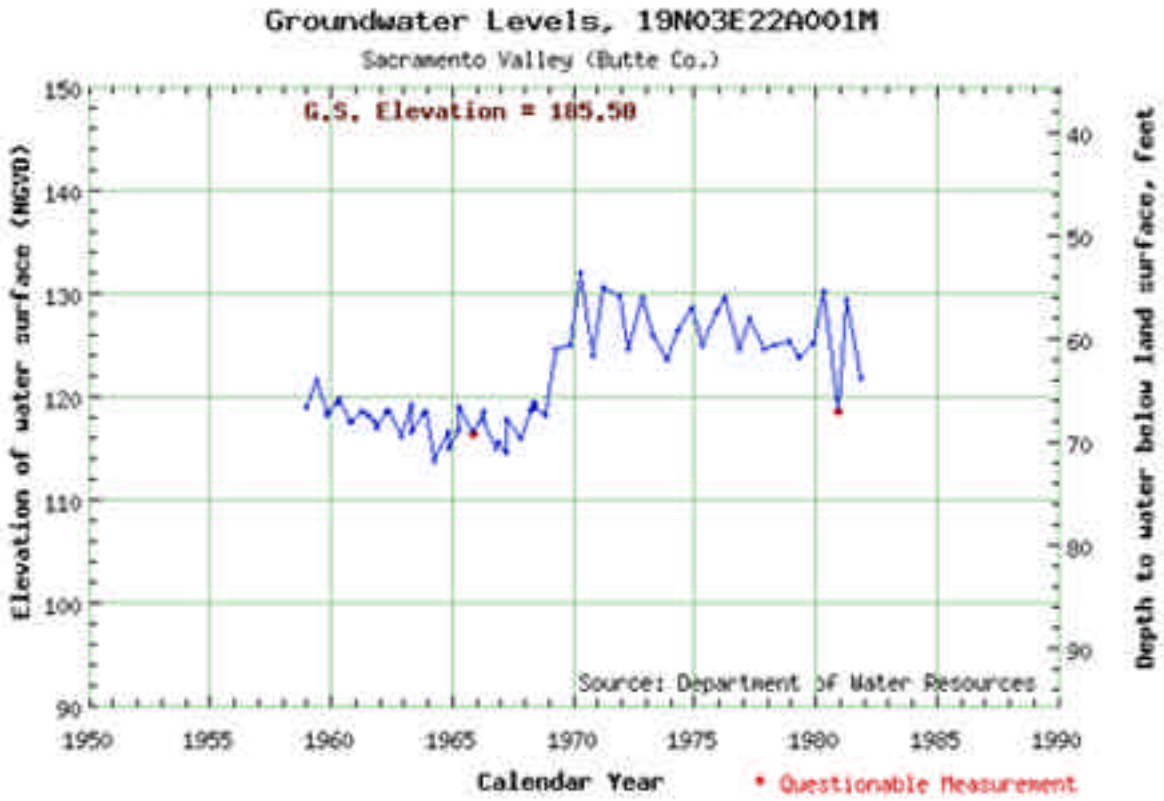

Figure 3. Groundwater levels in the vicinity of the Thermalito Forebay

~~The water level data from wells near the Thermalito Afterbay are insufficient to develop groundwater contour maps that have enough detail to show the possible effects of the project on the surrounding area (Figure 4). Local area pumping, loading of canals, flooding of fields, and back-pumping at the toe of the Afterbay all provide significant background noise.~~

A monitoring program was developed by DWR after completion of the project to evaluate water levels and pore pressures in the embankment impounding the Afterbay. A series of piezometers was placed along or near the Afterbay embankment and are monitored on a weekly, bi-weekly, or monthly basis. However, the data from these piezometers are not appropriate to use in ~~contouring~~determining area groundwater levels since the data may merely indicate leakage from the Afterbay rather than area groundwater levels. ~~and~~ In addition, back-pumping at the Afterbay affect the data from these piezometers.

Northern District staff made several attempts to field locate the numerous piezometers ~~located~~ to the west and southwest of the Afterbay originally used to evaluate seepage from the Afterbay following construction ~~that had been~~ but since abandoned by DWR. Twelve of these piezometers were located and have been added to

the Northern District monthly monitoring grid. These piezometers will provide ~~some limited~~ data on groundwater levels near a portion of the Afterbay.~~, but additional monitoring wells will be required to provide sufficient areal extent and resolution for groundwater elevation contours and flow gradient determinations.~~

Butte County has an extensive groundwater level monitoring network (Ed Craddock, Butte County Department of Water and Resource Conservation, pers. comm.). With about 80 wells in the network, there is little concern at the local level for additional groundwater level data.

Existing Groundwater Quality Monitoring – Thirteen wells have been monitored for water quality in the area (Figure 4~~5~~). However, since groundwater in the area moves in a south-southwesterly direction, the project has the potential to affect only two of the wells that have been previously monitored within a mile of the project. Available water quality data are very limited for these two wells, as well as others in the area. Nutrients and metals data are only available from one of the wells (12G01). Minerals have been sampled only once from well 24A01, but several times both prior to and following project construction from well 12G01. Pre- and post-project mineral data from this well are similar, though nitrate levels may be somewhat higher in data collected since project completion. Similarly, physical data have been collected only once from well 24A01, but both prior to and subsequent to project construction from well 12G01. Conductivity was generally less in this well prior to project completion, but also ranged in pre-project samples to as high as levels found in post-project samples.

Minerals were present at much greater levels in the only sample collected from well 24A01 than from samples collected from the Afterbay. Minerals in well 12G01, with the exception of potassium, were also present at much greater levels than from the Afterbay, but, with the exception of sulfate and chloride, were at lower levels than found in well 24A01. ~~Samples~~ Analyses for other constituents (nutrients, metals~~inor elements~~) ~~were~~are too few for comparison.

W~~hile w~~ell 24A01 is adjacent to the Afterbay, but the depth and construction are not known. W~~w~~ell 12G01 is over a mile away, which, lacking data from other wells closer to the Afterbay, makes use of this well questionable to determine any effects from the project. The paucity of data from only two wells, for~~one of~~ which the construction of one is not known and the other is over a mile from the project, makes meaningful determinations about project effects on groundwater quality impossible to ascertain.

Though groundwater level data indicate that the project has had a significant effect on water elevations in the vicinity of the Thermalito Forebay, no water quality data are available to determine effects to local groundwater quality from the project.

An accurate determination of project effects on groundwater quality cannot reliably be made due to the paucity of groundwater quality data in the immediate vicinity of the Thermalito Forebay and Afterbay. Most of the wells that have been previously monitored are several miles from the project, and the few wells nearer the project lack sufficient water quality data for determination of project effects.

The Butte County Integrated Watershed and Resource Conservation Plan emphasizes water quality (Ed Craddock, pers. comm). The County would like to see additional water quality monitoring to insure that the groundwater resources are being protected from contamination.

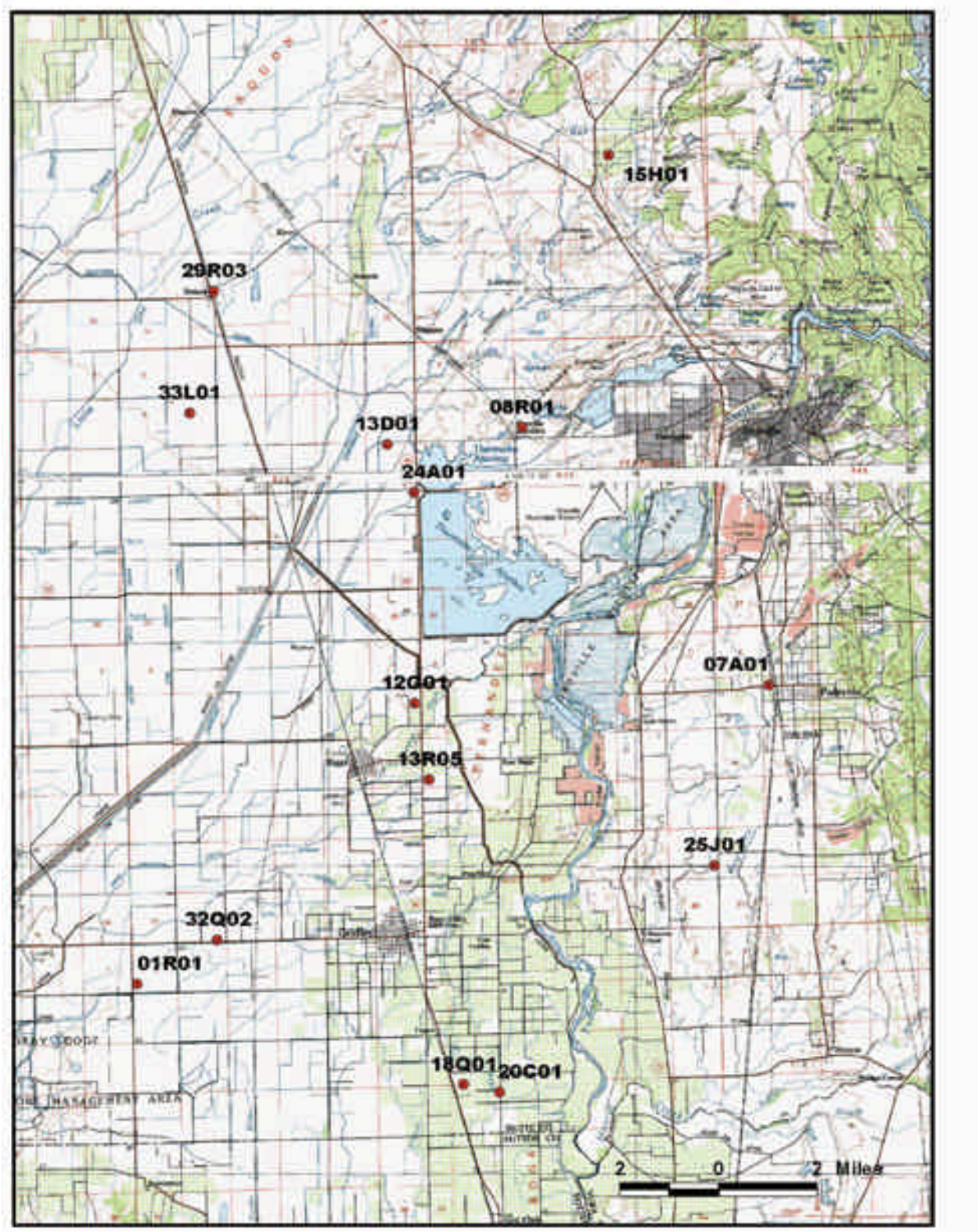

Figure 4. Groundwater quality monitoring wells near the Thermalito Forebay and Afterbay.

Phase Two Groundwater Monitoring – The wells previously monitored in the vicinity of the Thermalito Forebay clearly indicate the effects of the project on groundwater levels. However, since groundwater levels have not been identified as a concern and extensive groundwater level monitoring is already being conducted in the area by DWR and Butte County, no additional groundwater level monitoring is proposed.

~~Approximately 9 to 12 additional dedicated monitoring wells are suggested for installation to the west and southwest of the Afterbay to provide sufficient areal coverage where data are not currently available. Double completion wells should be installed at several sites to monitor the hydrologic connection between shallow and deeper aquifer zones.~~

~~Because the area under investigation is extremely flat, an elevation survey with a high level of accuracy is necessary to obtain adequate vertical control on groundwater level elevations, both for contouring and for determining flow directions and gradients. A level survey should be conducted to establish the ground and reference point elevations at each monitoring well site. The survey should include existing monitoring wells and the proposed new monitoring wells.~~

Due to the paucity of ~~groundwater quality~~ data in the project area and local concern for groundwater quality, additional ~~data are needed before~~monitoring is proposed to evaluate effects from the project on groundwater quality~~ can be evaluated~~. Surface water quality from the Thermalito Forebay and Afterbay and Feather River were reviewed to identify any constituents that may be elevated and hence could result in degradation of groundwater quality. Organic contaminants have not been found from the surface waters at levels greater than the minimum detection levels. Aluminum and mercury were the only metal constituents found in the surface waters that exceed water quality criteria (Appendix A). Nutrients have been found in the surface waters at very low levels and are less than those found in area groundwater (Appendix B). Surface water minerals, particularly calcium, magnesium, chloride, and hardness, are present in surface waters at concentrations that are significantly less than those found previously in area groundwater (Appendix C).

Additional groundwater quality data will~~should~~ be collected in the vicinity of both the Thermalito Forebay and Afterbay. The proposed monitoring for water quality will include the 11 wells currently monitored semi-annually for groundwater levels, 2 wells currently monitored monthly for groundwater levels, and 12 piezometers originally used to evaluate seepage from the Afterbay following construction (Figure 2). Attempts will be made to identify several additional existing shallow wells to include in the monitoring program to enhance areal coverage of the shallow aquifer. Groundwater quality will be measured during the spring and fall from the existing monitoring wells, piezometers, and domestic wells included in the study. ~~This will include routine sampling of previously monitored wells in the vicinity of the project, sampling other wells closer to the project itself, and sampling any wells developed to monitor groundwater levels.~~ Groundwater samples collected for additional monitoring will be analyzed for general mineral composition, aluminum, mercury, and physical parameters including pH, conductivity, and temperature at the time of sampling. The general mineral and physical parameter analyses will enable the ionic composition and physical characteristics of the groundwater to be compared with those of the surface waters collected in Study Plan SPW1 to provide an indication of connectivity. Aluminum and mercury will be analyzed to provide information on levels in the groundwater and possible link to surface water. Chemical analyses will be performed at the DWR Bryte Chemical Laboratory in West Sacramento, California, except that mercury analyses will be performed at Frontier Geosciences in the State of Washington.

~~Groundwater levels and quality will be measured in monitoring wells and piezometers. Active pumping wells will not be measured or sampled for water level, but may be included for water quality measurements. Groundwater levels will be measured monthly, while groundwater quality sampling will be conducted in the spring and fall.~~

~~Groundwater samples collected for additional monitoring will be analyzed for general mineral composition and physical parameters including pH, conductivity, and temperature at the time of sampling. The general mineral analysis will enable the ionic composition of the groundwater to be compared with the ionic signature of water collected from the Thermalito features in Study Plan SPW1. Similarly, the physical parameters of the groundwater samples can be compared to surface water samples from the Thermalito features.~~

~~Additional parameters may also be selected for groundwater monitoring if they are found in the Forebay or Afterbay in significant levels. These parametes may include methyl tert-butyl ether (MTBE), total and fecal coliform bacteria, metals, and select pesticides. Water quality data from SPW1 for the Forebay and Afterbay will be evaluated to determine which additional parameters may also be analyzed from groundwater samples. All chemical analyses would be performed at the DWR Bryte Chemical Laboratory in West Sacramento, California. Analyses for coliform bacteria would be conducted at the DWR laboratory in Red Bluff, California.~~

6.0 Report

A report will be prepared following the conclusion of the second phase in which all data are presented in appendices, and the potential ~~e~~affects of the Thermalito Forebay and Afterbay on groundwater ~~levels and~~ quality ~~are~~is assessed. The report will contain tables, graphs, figures, and maps, and will include evaluation of ~~the~~ groundwater influences of Thermalito project waters on shallow groundwater ~~levels and~~ quality. Groundwater ~~level and~~ quality data collection will~~ould begin~~ occur in the spring and fall of 2003~~, and may continue through the fall of 2004~~. A draft ~~-~~report will~~ould~~ be completed ~~in~~ by January 2004 ~~following data collection activities~~.